ARRIFLEX D-21

The Film Style Digital Camera

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The Film Style Digital Camera

The ARRIFLEX D-21 combines leading edge digital technology with film camera features that have been refined over ARRI's 90-year history. It allows directors and cinematographers to shoot in the same way as they would with 35 mm film, while taking advantage of the immediacy and economy of digital acquisition.

Through ARRI Imaging Technology (AIT), the D-21 produces brilliant images with a cinematic look and feel. D-21 images have a high dynamic range, high contrast and the most film-like color reproduction of any digital motion picture camera.

Incorporating a rotating mirror shutter, optical viewfinder and compatibility with existing film accessories, the D-21 is immediately recognizable as an ARRI camera and film crews feel comfortable operating it. Further film style features include variable frame rate and robust construction.

The D-21's single, Super 35-size CMOS sensor exhibits the same cinematic depth of field as 35 mm film and the camera's industry standard PL lens mount accepts the same unequalled variety of spherical lenses as used on 35 mm film cameras. Since the D-21 is the only digital high-end camera with a 4x3 aspect ratio sensor, it can make full use of anamorphic lenses.

The ARRIRAW format enables the D-21 to output raw uncompressed data. Alternatively – or simultaneously – the camera can output an uncompressed HD signal that works perfectly in the established HD infrastructure. With such flexibility, the D-21 easily adapts to a variety of production requirements and budgets.

ARRI
LDS
RDY
ZOOM
FOCUS
IRIS
RF CHAN
MP
21
ARRI
TILT LOCK
ARRI

ARRIFLEX D-21 – Main Features

■ **Cinematic Image Quality**

- ARRI Imaging Technology for a cinematic look
- rotating mirror shutter for film-like motion portrayal
- single, Super 35 size sensor for 35 format depth of field
- highest dynamic range of any digital motion picture camera
- super sharp, alias-free images
- extended color space for natural, film-like color reproduction
- consistent matching between cameras

■ **Flexible Output Option**

- simultaneous data and HD outputs possible
- Data Mode: 4x3 ARRIRAW
  uncompressed data for film-like data workflow
- Data Mode: ARRIRAW T-Link connects camera
  to data recorders
- HD mode: 16x9 uncompressed HD output
- HD Mode: Linear or Logarithmic,
  4:2:2 YCbCr or 4:4:4 RGB, Normal or Extended Range
- Fiber optic option allows cable length of up to 500 m/1,600'

■ **ARRI Imaging Technology (AIT)**

- custom designed CMOS sensor
- powerful imaging hardware engine
- unique ARRI image processing software
- carefully tuned system integration

■ **Modular Architecture**

- sensor, electronics and firmware can be upgraded
- secure investment
- long product cycle

■ **Optical Viewfinder**

- zero delay
- outside image area
- bright, full color image
- works without power
- fatigue-free viewing

■ **35 Format Film Lenses**

- industry standard PL mount
- unequalled variety of prime, zoom and specialty lenses
- compatible with spherical and anamorphic lenses (1.33:1 sensor format)

■ **Compatibility with 35 Format Film Accessories and Support Equipment**

- ARRI matte boxes, follow focus, wireless remote control
- dollies, cranes, Steadicam, etc.

■ **A True ARRI Camera**

- silent running
- simple operation
- robust construction
- ergonomic design
- variable speed and shutter angle

ARRI Imaging Technology

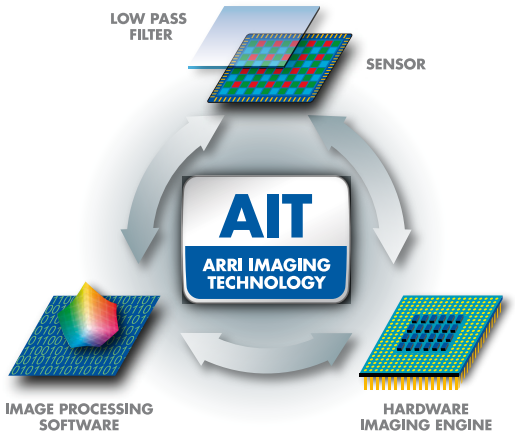
Each component of the D-21 has been purpose-built with one goal in mind: to create the most gorgeous cinematic images possible. Those images are the result of a custom designed CMOS sensor, a carefully crafted optical low pass filter, a powerful imaging hardware engine and advanced image processing algorithms. Having full control of the D-21's imaging chain down to the smallest detail allows an optimization of the whole system far beyond what would be possible with off-the-shelf components. The smart orchestration of all these proprietary components is ARRI Imaging Technology (AIT).

AIT, which is in constant development, combines ground-breaking research and development with knowledge, feedback and suggestions gleaned from an on-going dialogue with professional filmmakers. AIT provides super sharp, alias-free images through over sampling, a finely tuned optical low pass filter and advanced image reconstruction algorithms.

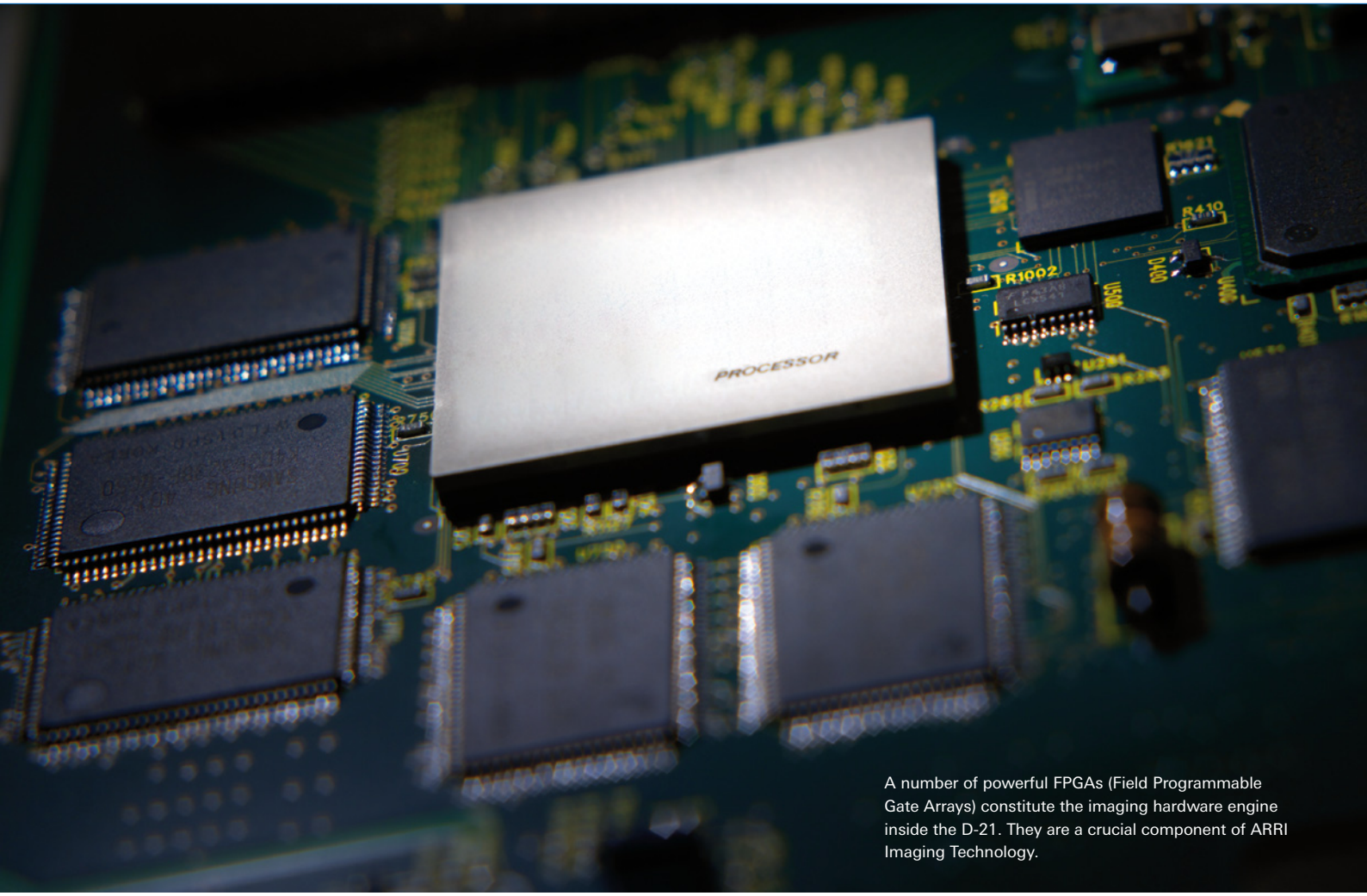
Image processing advances incorporated into the D-21 include increased sensitivity, with 'linear' HD output ranging between EI 100 and EI 800 equivalent, as well as optimized sharpness and enhanced, film-like color reproduction.

AIT also ensures that crews can concentrate on the creative aspects of making images, by automating many of the technical aspects. The D-21 has, for instance, an automated black balancing circuit (Correlated Double Sampling - CDS), which continuously calibrates the black level of each pixel in each frame without any user intervention. In addition, an automated Defect Pixel Correction (DPC) guarantees that no single defective pixel will ever be visible. DPC is a highly sophisticated process that analyzes every pixel plus a surrounding pixel field in every frame (for a staggering total of 2.5 billion pixels analyzed each second) in real-time as the camera is running.

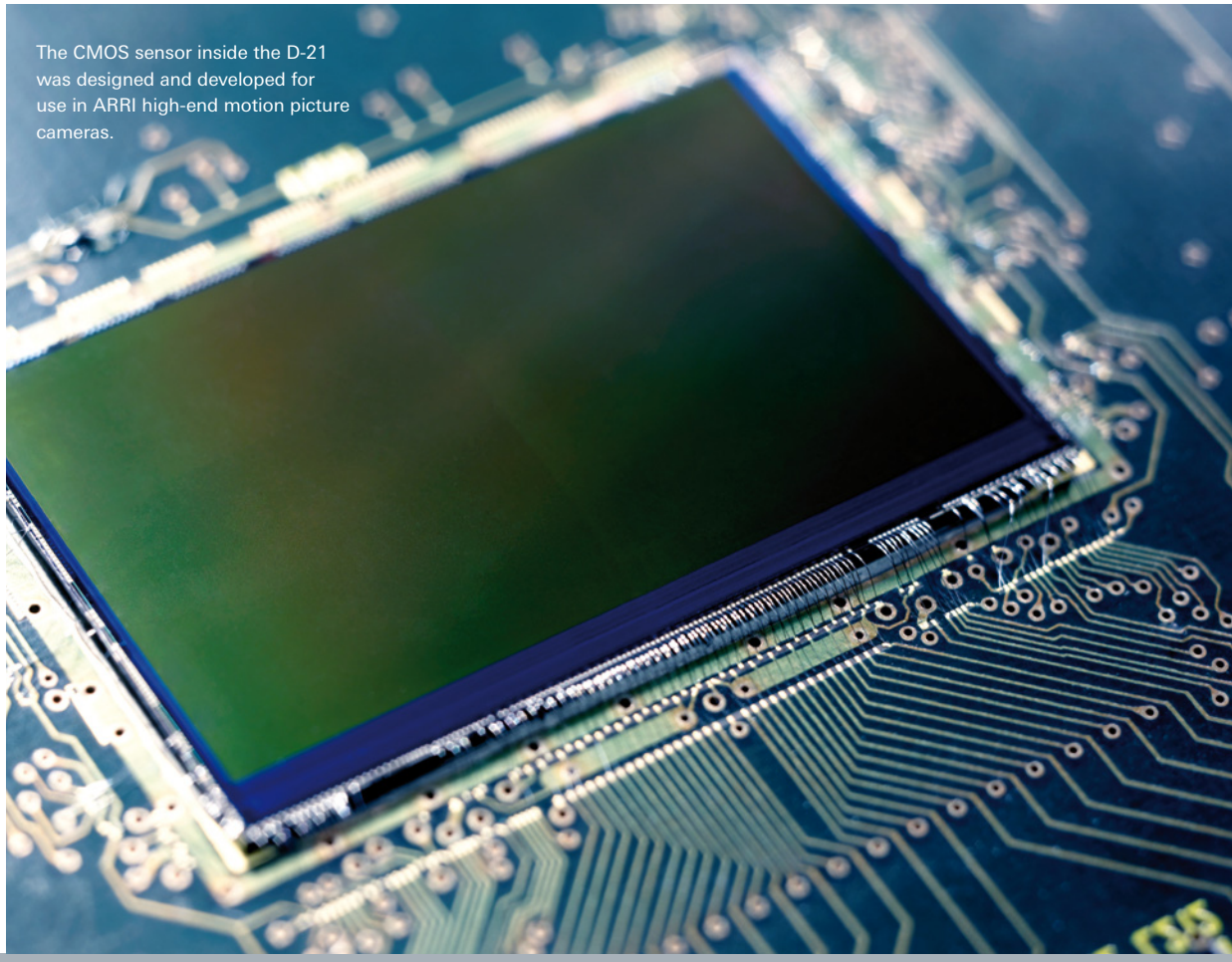
Through AIT, the D-21 produces outstanding images with a cinematic look and feel, high contrast, the highest dynamic range and the most film-like color reproduction of any digital motion picture camera.



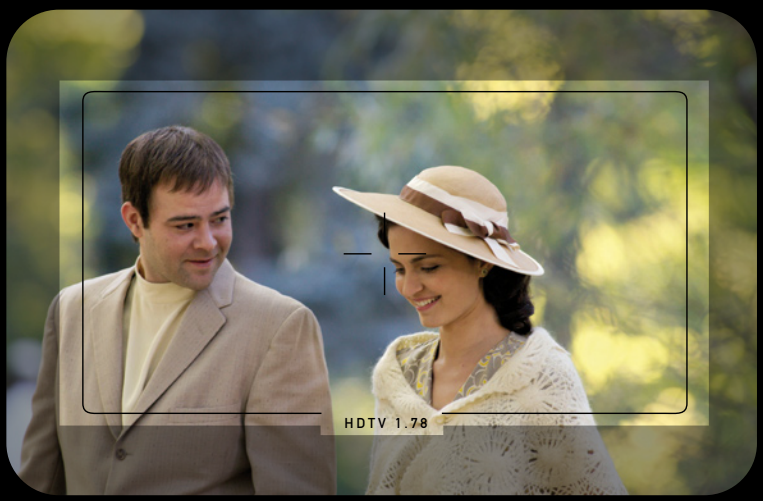
STATE OF THE ART TECHNOLOGY



A number of powerful FPGAs (Field Programmable Gate Arrays) constitute the imaging hardware engine inside the D-21. They are a crucial component of ARRI Imaging Technology.



The CMOS sensor inside the D-21 was designed and developed for use in ARRI high-end motion picture cameras.



An optical viewfinder is the preferred choice of both cinematographers and camera operators. The clear, full color image enables accurate assessment of focus and facilitates precise and comfortable operating for complex camera moves. Most crucial of all is the fact that an optical viewfinder shows an image larger than that being recorded and therefore allows the operator to see not just what is in frame, but also what is just outside the frame. This safety area permits meticulous composition and helps the operator prevent unwanted objects (such as a boom or microphone) from entering a shot.

The Company; Photo: © Sony Pictures TV

A CLEAR VIEW

The Optical Viewfinder

While most digital cameras use electronic viewfinders, the D-21 is equipped with the same optical viewfinder as all other ARRI cameras. Thus the D-21 viewfinder always shows an image area larger than the image being recorded, and it can be used even when the camera is not powered up.

Light entering the taking lens is diverted by a spinning mirror shutter and generates a bright, magnified full color image in the viewfinder. This direct light path, free of any electronic image processing, ensures fatigue-free viewing as well as zero delay, a crucial feature when shooting fast action, where a delay of even a few frames can be very confusing. But even something as mundane as following a person getting up from a chair can become horrifying guesswork if the viewfinder image is delayed.

The D-21 optical viewfinder can be freely rotated, extended or flipped to the other camera side for comfortable viewing in any camera position An extension viewfinder, eyepiece leveler and a heated eyepiece are useful accessories in many shooting situations.

A Film Sized Sensor & Film Lenses for a Film Look

Depth of field is the one of the most powerful creative tools available to cinematographers, and the shallow depth of field of 35 mm film cameras has become associated with cinematic imagery in the minds of movie audiences over the last 100 years. The D-21's sensor has the same size as a Super 35 mm film frame to give cinematographers the same versatility and control of depth of field.

Having a wide range of lenses available is of immense importance, as it gives cinematographers the greatest flexibility in expressing their vision. The 35 film format enjoys the widest variety of prime, zoom and specialty lenses available for any format, and the D-21 is compatible with all those lenses thanks to its industry standard PL lens mount. Since the D-21 is the only high-end digital camera with a 4x3 aspect ratio like 35 mm film, it is also the only digital camera that can take full advantage of the unique CinemaScope look of anamorphic lenses.

Further enhancing the film-like quality of D-21 images is the camera's rotating mirror shutter, which functions exactly as it does on 35 mm ARRI film cameras. This method of progressive image capture results in the most film-like motion portrayal possible.

The ARRIFLEX D-21 is the only digital high-end camera that can make full use of anamorphic lenses for the CinemaScope format.

The D-21 PL mount. Inside, the sensor is visible on the left, and the half closed mirror shutter is visible on the right.

The image, as recorded by the D-21 with an anamorphic lens.

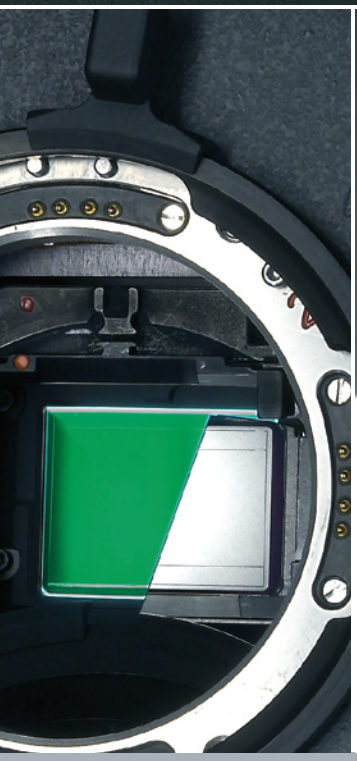
A simple 2:1 stretch and slight crop of the sides in post results in a CinemaScope format image.

Typical 2/3" video camera sensor
aspect ratio: 1:1.78
dimensions: 9.40 mm x 5.30 mm / 0.370" x 0.209"

D-21 sensor active pixel area
aspect ratio: 1:1.33
dimensions: 23.76 mm x 17.82 mm / 0.9354" x 0.7016"

ANSI Super 35 Silent camera aperture
aspect ratio 1:1.33
dimensions: 24.90 mm x 18.70 mm / 0.980" x 0.7362"

The left upper area shows the D-21 sensor on its electronic backplane. The right bottom area shows the sensor frame that also holds the protective glass and the low pass filter.



The D-21 mirror shutter. The mirror portion can be seen to the left, and to the right the variable shutter blade is visible, here restricting the open shutter angle to 11.2°.

The Company; Photo: Jan Thijs © Turner Broadcasting 2006

The Company; Photo: © Sony Pictures TV

The Company; Photo: © Sony Pictures TV

The Andromeda Strain;
Marty McNally, A Camera Operator (center)
with Jon Joffin, Cinematographer (right)
Photo: © A&E/Diyah Pera

FROM THE FIELD

Mikael Salomon, ASC -
Director of *The Company* and *The Andromeda Strain*

"I'm very pleased with the final look of the six-hour miniseries The Company, which we shot in Canada, Hungary and Puerto Rico under very varied circumstances."

"I've had questions from industry professionals asking how much was digital and how much was shot on film. Great surprise when they learn that it was all digital except for a few slo-mo shots - the film intercuts seamlessly with the digital images."

"Ridley [Scott] asked me to direct another miniseries and we decided - once again - to go with the ARRI digital camera. We're currently shooting in the Vancouver and getting great feedback on dailies."

"I've been fielding calls from DP's interested in using the ARRI digital camera system. As I tell them, the best recommendation is that I'm using it again!"

The Company; from left to right:
Michael Zimbrich (1st AD), Ben Nott (Cinematographer),
Michael Carella (A Cam OP), Michael Salomon (Director)
Photo: Jan Thijs © Turner Broadcasting 2006

D-21 Data Mode Main Features

■ **Best Image Quality**

- records uncompressed, unprocessed 12 bit raw Bayer sensor data (ARRIRAW)
- the output option with the highest dynamic range and lowest noise
- improved image quality through advanced image reconstruction in post
- 2880 x 2160 (4:3) at 24 and 25 fps
  2880 x 1620 (16:9) at 30 fps

■ **CinemaScope**

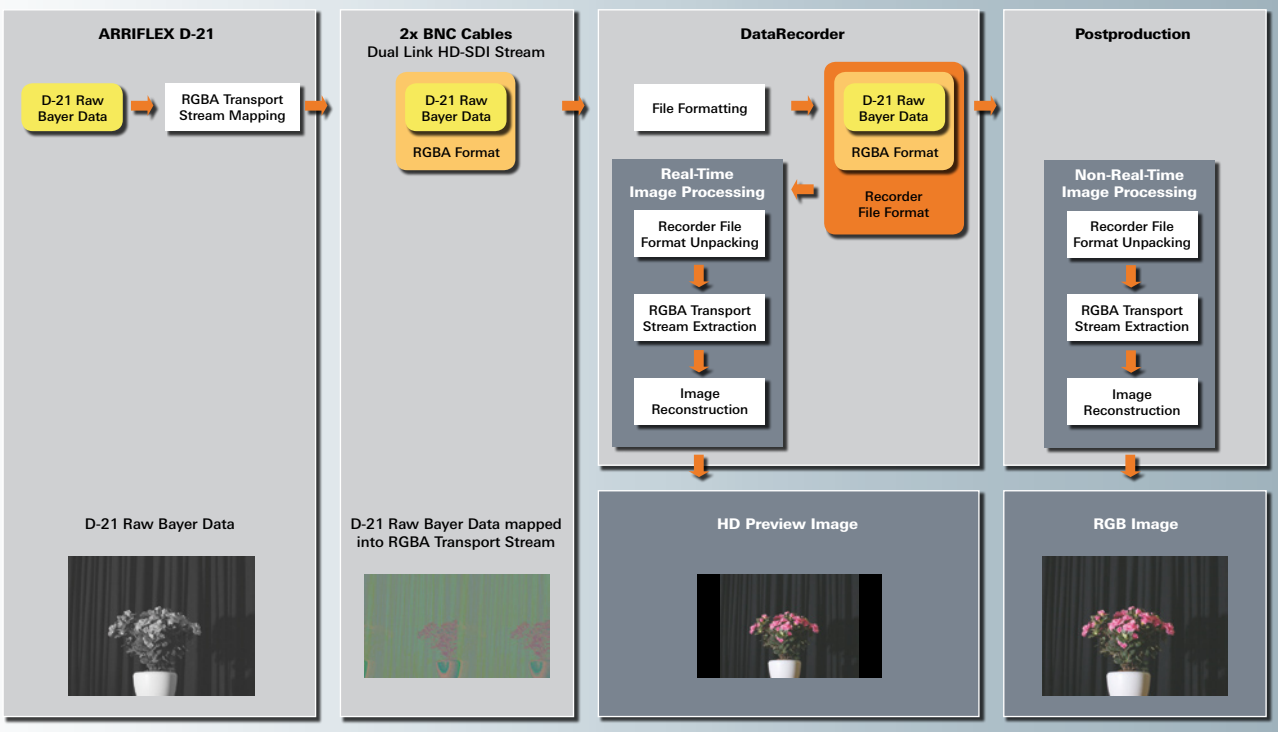
- anamorphic lenses can be used

■ **Greatest Flexibility on the Set**

- ARRIRAW T-Link: transport ARRIRAW via dual link HD-SDI
- simultaneous data and HD output for HD video monitoring and offline editing
- ingest converted data files from data recorder to NLE

■ **Greatest Flexibility in Post**

- finer detail and crisper edges
- higher resolution works better for compositing
- familiar workflow: 2K output files have the same resolution and colorimetry as 2K scans from film
- color conversion and lookup table decisions can be made in post
- simple image reposition and cropping
- upgraded image reconstruction can be applied to archived raw data for better image quality



FLEXIBLE OUTPUT OPTIONS

Different Productions Require Different Outputs

Different projects have different production requirements, budgets and distribution channels; the equipment chosen has to be flexible enough to accommodate those differences. The unique construction of the ARRIFLEX D-21 allows various output signals to be generated, accommodating diverse production needs and pipelines.

In HD Mode, HD output options include 'Linear' or Logarithmic output, 4:2:2 YPbPr or 4:4:4 RGB, Normal or Extended Range, as well as frame rates of up to 60 fps and an optional fiber optic link. HD Mode allows the D-21 to deliver its unique images into the existing HD infrastructure.

Alternatively, or even concurrently, the D-21 can work in Data Mode, whereby the uncompressed, 12 bit raw Bayer data from the D-21's 4x3 sensor is available in full resolution. The ARRIRAW T-link (Transport Link) is a method of transporting the ARRIRAW data over a standard dual link HD-SDI connection. The data files which result from processing of the ARRIRAW recordings are as easy to grade as those scanned from film because they have the same pixel raster and colorimetry as film scans.

Data recorders that can record and play back the ARRIRAW T-Link signal can be certified by ARRI.

ARRIRAW T-Link

One of the obstacles that has held back the use of raw data in the past has been the problem of how to get data easily from the camera to a recorder. ARRI engineers have found a way to utilize a standard dual link HD-SDI connection to transport the raw D-21 Bayer data. This new transport method is called "ARRIRAW T-Link" (Transport Link). It allows any recorder capable of recording an uncompressed dual link HD-SDI stream to record raw D-21 Bayer data, greatly simplifying the raw data workflow for manufacturers and users alike.

The properties of the dual link HS-SDI connection are defined in SMPTE 372M. The standard specifies a maximum data rate of 2.97 Gb/s, which is enough bandwidth to carry the 12 bit D-21 raw Bayer data. SMPTE 372M also defines a number of standardized source signal formats to be sent through two BNC cables (affectionately known as Link A and Link B).

One of those source signal formats is the RGBA format. RGBA stands for red, green and blue plus an alpha channel, technically called 4:4:4:4 (R'G'B'+A)/10 bit. The ARRIRAW T-Link works by mapping the 12 bit raw Bayer data into this RGBA data stream, so that it can be transported via a dual link HD-SDI connection.

Any recorder that is capable of recording a SMPTE 372M compliant RGBA signal and playing it back without compression or further encoding can record this signal. If the signal is recorded by a data recorder, the additional option of a live preview exists. The data recorder can extract the original D-21 raw Bayer data out of the RGBA data stream, and use a real-time image reconstruction algorithm to display the 4:3 image as a 1440 x 1080 preview HD image. If anamorphic lenses are used on the D-21 a suitably "de-squeezed" image can be displayed on an HD monitor.

A similar but more refined process is used in postproduction. The original raw Bayer data is extracted from the RGBA stream, and advanced image reconstruction algorithms are used to reconstruct a pristine image in HD, 2K or 2.8K. Doing this in post has the added advantage that it does not have to be done in real-time, so a significantly better image quality and greater flexibility are possible. Note that throughout the whole process, the image always stays uncompressed, at the highest quality.

A True ARRI Camera

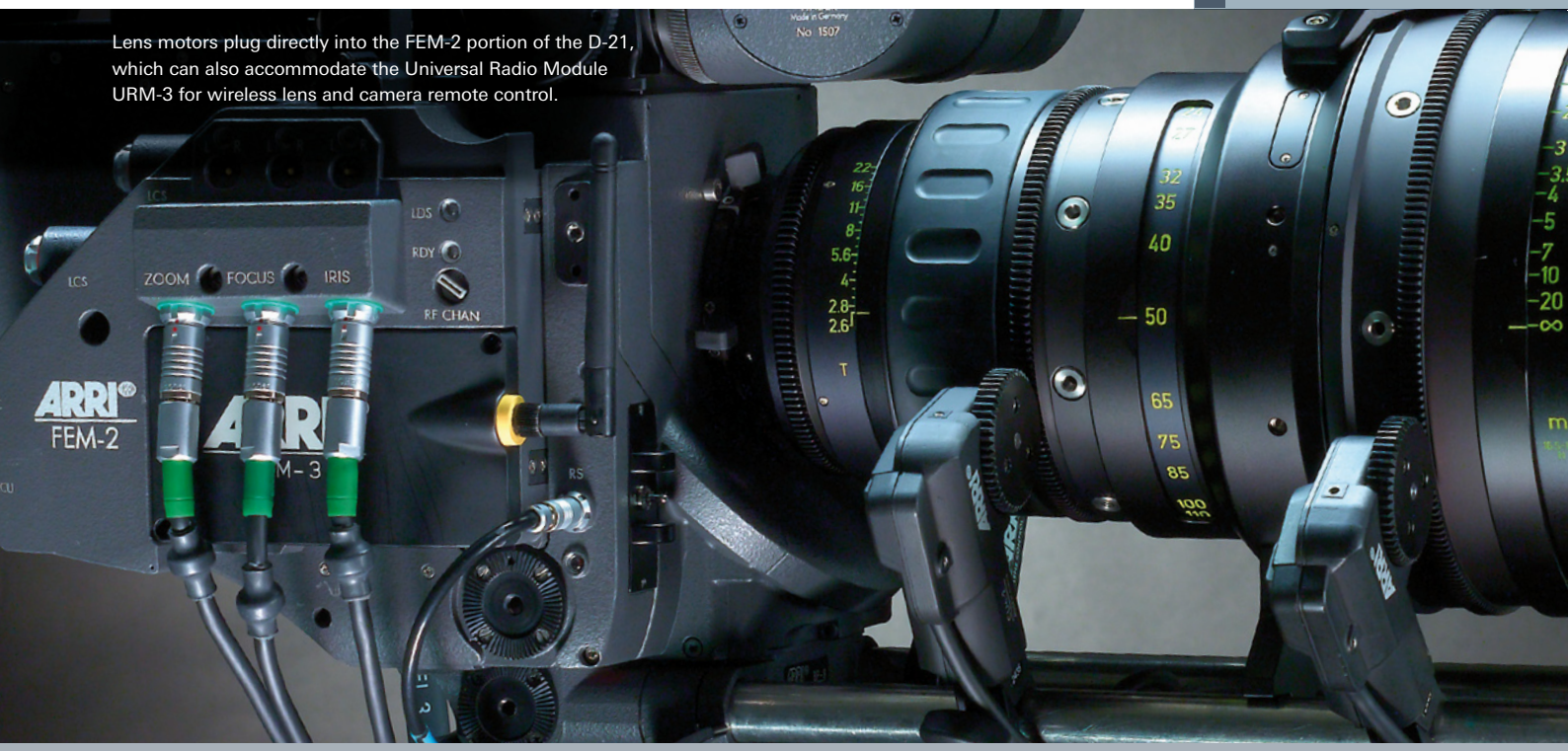
The D-21 is a true ARRI camera; it runs silently and has the same robust construction and ergonomic design ARRI cameras are famous for. Its controls are also simple and straightforward for fast and safe operation.

The D-21 is also compatible with a broad selection of film accessories. Mounted on a standard sliding baseplate, the D-21 shares matte box, support rod and follow focus options with the ARRI 35 mm film cameras.

The extensive range of available accessories allows the D-21 to be configured for any style of shooting. A studio setup might involve a production matte box and follow focus, extension eyepiece with leveler and a heavy zoom lens, while a stripped-down setup would permit handheld or Steadicam shooting.

The FEM-2, a Functional Expansion Module that attaches to the side of the D-21, houses a built-in radio module for lens and camera control with the ARRI Wireless Remote System (WRS). It also contains motor drive electronics that allow the ARRI Controlled Lens Motors (CLM) to be plugged directly into the D-21, minimizing the number of boxes attached to the camera.

The D-21's modular system architecture allows upgrading when advances in sensor, electronics or firmware technology become available, thus ensuring a long product cycle for the camera.



Lens motors plug directly into the FEM-2 portion of the D-21, which can also accommodate the Universal Radio Module URM-3 for wireless lens and camera remote control.

ARRI
ARRIFLEX D-21

ARRI
WFU-3
IRIS
FOCUS
LENS
KNOB
LENS
FOCUS
IRIS

ARRIFLEX D-21
ZOOM
FOCUS
IRIS
RF CHAN
ARRI
FEM-2
MP
150

The Butcher's Shop; Cinematographer Sean Bobbitt, BSC

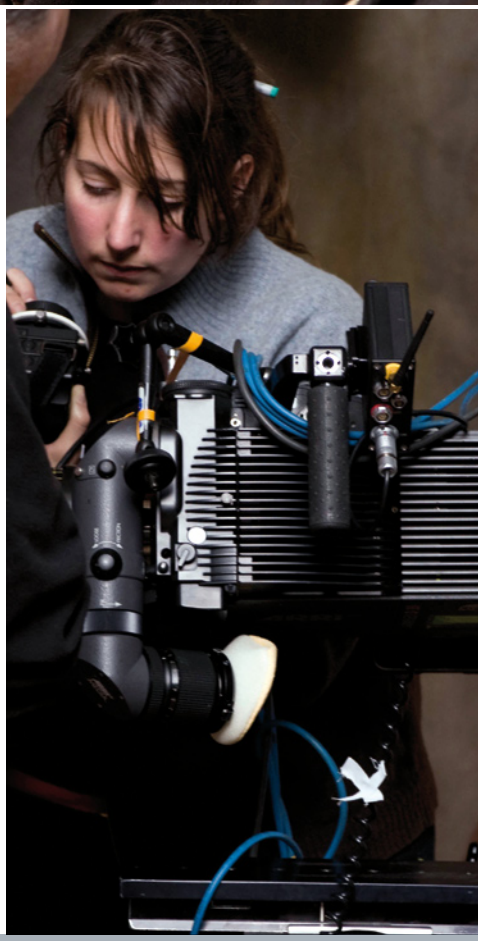
Photos: © Andy Subratie

Sean Bobbitt, BSC - Cinematographer on *The Butcher's Shop*

"The fact that you can work in log space and use LUTs to see the image on monitors on set is fantastic. It gives the director such confidence"

"I've been shooting digital RAW with stills photography for some time and have recognised the clear benefits. It just seemed logical to me that this is the next step, in terms of pushing the camera to its limits and getting the best possible quality imaging straight off the chip itself - avoiding all the processing and compression."

"In Data Mode you have the highest quality of information – not just resolution but color information as well – all the way through the workflow, so when you come to the grade you're not working with degraded, compressed images, which for me have always been the biggest drawback of all the other HD formats."



FROM THE FIELD

Jason Statham stars in THE BANK JOB. Photo: © Jack English

Michael Coulter, BSC - Cinematographer on *The Bank Job*

"After using the ARRI digital camera on The Bank Job, I was very pleased with the end result. I look forward to the future developments of this camera."

Before and after compositing:
the final scene with visual effects and Seattle background footage.

Sam Nicholson - Cinematographer and VFX Supervisor on VFX scenes for *Grey's Anatomy*

"As predicted, it pulled the keys beautifully and the cinematography looks great as well."

Sam Nicholson - Cinematographer and
VFX Supervisor on VFX scenes for Grey's Anatomy
Photos: © American Broadcasting Companies, Inc.

John Pardue - Cinematographer on *Frequently Asked Questions About Time Travel*

"The camera is pretty much the same as a film camera in many ways: it has a great viewfinder and the same control panel as a 435. It's also wonderfully simple to operate".

"Another impressive aspect is the shallow depth-of-field, which is similar to 35 mm."

"It copes with bright skies and allows you to open up for the shadow areas without the worry of blowing things out."

Frequently Asked Questions About Time Travel; Cinematographer John Pardue

Tin Man; Photo: © James Dittiger/SCI FI Channel

FROM THE FIELD

Thomas Burstyn - Cinematographer on *Tin Man*

"We were very pleased with the look - great saturation, incredible acutance and resolution."

Tin Man; Director Nick Willng (right), Cinematographer Thomas Burstyn (left)
Photo: © James Dittiger/SCI FI Channel

Prisoners of the Sun; Cinematographer Ed Wild

Ed Wild - Cinematographer on *Prisoners of the Sun*

"Because it's a full-sized chip and a PL mount, there is a full choice of all the film lenses."

Prisoners of the Sun; Photo © Miromar Entertainment AG

Afrika Mon Amour;
Camera equipped with
"workhorse" ARRI Master Zoom

Frank Küpper - Cinematographer on *Afrika, Mon Amour*

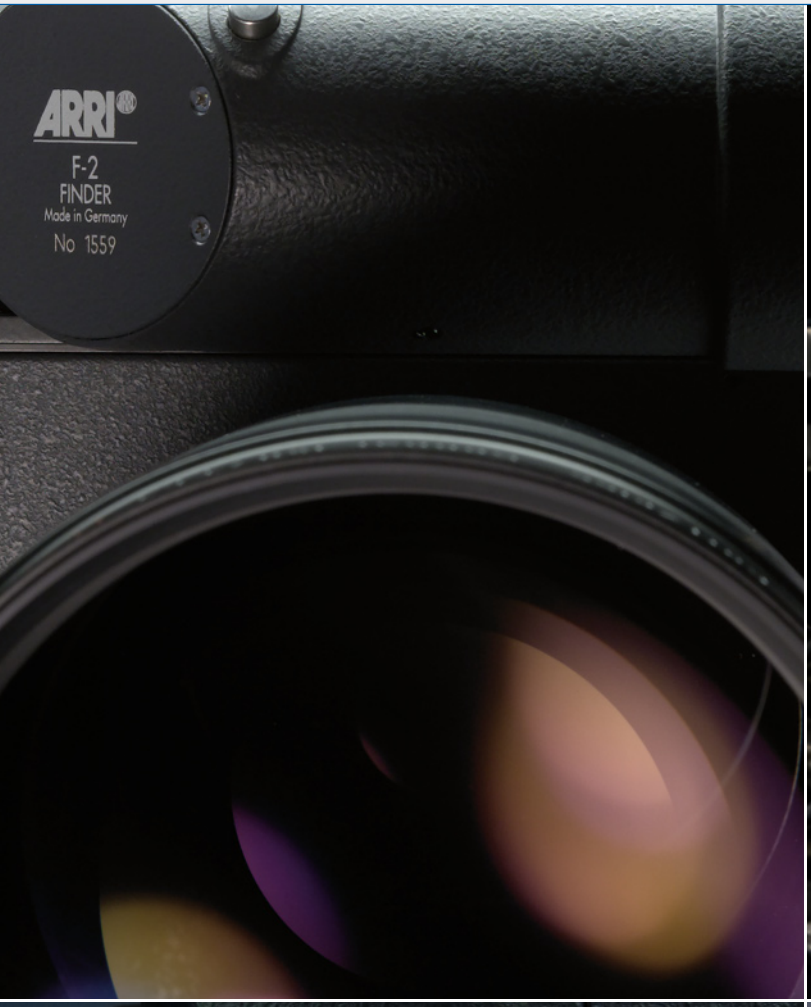
"No grain, instant availability of full resolution images and a 35 mm look."

Afrika Mon Amour;
Cinematographer Frank Küpper framing a detail shot,
Photos: © Andras Berkl

Technical Data

Camera Type	35 format digital film style camera with optical viewfinder.
Frame Rate	20 - 60 fps forward in HD Mode (16:9), 20 - 30 fps forward in Data Mode (16:9), 20 - 25 fps forward in Data Mode (4:3), all speeds crystal and can be set with 0.001 fps precision. Does not run in reverse.
Aperture	23.760 x 13.365 mm/0.9354" x 0.5262" in HD Mode, 23.760 x 17.820 mm/0.9354" x 0.7016" max. in Data Mode.
Lens Mount	54 mm PL mount, centered for Super 35, with Lens Data System contacts (LDS). Flange focal depth 52 mm nominal.
Display	Camera display on left side with individual buttons for: camera RUN, PHASE (electronic inching & mirror rotation), NORM-PS/CCU control, LOCK, MODE, SEL and SET. Allows setting programmable fps, beeper volume, beeper at start and/or stop, enable/disable mirror shutter, mirror shutter angle, frame counter. Video Menu over composite video output for control of operational parameters: HD Mode/Data Mode, standard frame rates, white balance and color matrix, signal output range, contrast characteristic and sensitivity.
Shutter	Electronically adjustable mirror shutter. Adjustable through camera menu to 11.2°, 22.5°, 30°, 45°, 60°, 75°, 90°, 105°, 120°, 135°, 144°, 150°, 172.8° and 180°.
Viewfinder	Optical reflex viewfinder with interchangeable ground glass, spherical or universal (adjustable to spherical and anamorphic) viewfinders available. Viewfinders are adjustable in two axes with automatic or manual image compensation, laterally extendable for left eye operation and show illuminated frame lines (ARRIGLOW, adjustable in brightness). Optional medium or long finder extender including magnifier. Optional heated eyecup.
Video	SD monitoring (PAL/NTSC video downscaled from captured image).
Signal Output	**HD Mode – HD-SDI (SMPTE 292M):** - 1920 x 1080 4:2:2 YCbCr 10 bit @ 23.976, 24, 25, 29.97, 30PsF **HD Mode – dual link HD-SDI (SMPTE 372M):** - 1920 x 1080 4:2:2 YCbCr 10 bit @ 48, 50, 59.94, 60PsF, - 1920 x 1080 4:4:4 RGB 10 bit @ 23.976, 24, 25, 29.97, 30PsF **Data Mode – ARRIRAW T-Link** **(ARRIRAW transmission protocol mapped into RGBA dual link HD-SDI stream according to SMPTE 372M):** - 2880 x 2160 RAW 12 bit Bayer data @ 23.976p, 24p, 25p, - 2880 x 1620 RAW 12 bit Bayer data @ 29.97p, 30p
Recording	HD recording devices supporting HD-SDI (SMPTE 292M) or dual link HD-SDI (SMPTE 372M) signals for HD Mode operation. Optional on-board HD recording using solid-state memory recorder Flash Mag. ARRIRAW T-Link compatible recording devices for Data Mode operation.
Connections	2x dual link HD-SDI out, 2x composite video out (CVBS), 1x S-Video out (Y/C), 1x power in (BAT), 1x 12 V accessory power out (Fisher 11-pin), 1x 24 V accessory power out (RS), 1x lens data display (LDD), 2x lens control system bus (LCS), 1x accessory interface (ACC), 1x camera control unit (CCU), 1 each focus, iris, zoom for lens motors.
Power	24V DC (acceptable voltage range: 20.5 to 36 V DC)
Power Consumption	2.1 A @ 24 fps, 1.9 A in Standby
Sound	Less than 20 dB(A) @ 24 fps
Dimensions	Length: 39 cm/15.35" Width (viewfinder left): 27 cm/10.83" Height with handle: 30 cm/11.81" Height without handle: 23 cm/9.06"
Weight (without lens)	Body only: 8.6 kg/19.0 lbs Body and viewfinder: 10.9 kg/24.0 lbs
Accessories	Accepts the whole range of ARRI matte boxes, 15 mm or 19 mm rod systems, follow focus and ARRI electronic accessories, Lens Control System (LCS), Lens Data System (LDS), Wireless Remote System (WRS), Wireless Remote Control WRC-2, Iris Control Unit for speed/iris ramps (ICU-1), Remote On/Off Switch (RS-4), Integrated Video System (IVS), External Synchronization Unit (ESU-1). Specifically for ARRIFLEX D-21/D-21 HD: Low mode support set for Steadicam operation or underslung use and top-mounting of accessories without bridge plate, Flash Mag Mounting Adapter (FMA-1), Sony Fiber Interface (SFI-1) and Sony Fiber Remote (SFR-1).
Misc.	Extra attachment points for rigging.

All data subject to change without notice.


ARRI
F-2
FINDER
Made in Germany
No 1559

Power Temp. Diagn.
Service
Y/C
HD-SDI 2
CVBS1
CVBS2

RUN
LOCK
NORM
180.0
fps
25.000
MODE
PS/CCU
SEL/▽
PROG.
SET/△

Germany

Arnold & Richter Cine Technik (Headquarters, Sales & Service)
Türkenstraße 89, D-80799 Munich, Germany
Tel: +49 (0)89 3809 0, Fax: +49 (0)89 3809 1245

Great Britain

ARRI GB Limited (Sales & Service)
2 Highbridge, Oxford Road, Uxbridge, Middlesex, UB8 1LX, Great Britain
Imaging Equipment Sales: Allan Fyfe, afyfe@arri-gb.com
Tel: +44 (0)1895 457 000, Fax: +44 (0)1895 457 001

Italy

ARRI Italia S.r.l. (Sales & Service, Milan)
Viale Edison 318, 20099 Sesto San Giovanni (Milano), Italy
General Manager: Antonio Cazzaniga, acazzaniga@arri.it
Tel: +39 (02)262 271 75, Fax: +39 (02)242 1692

ARRI Italia S.r.l. (Sales & Service, Rome)
Via Placanica 97, 00040 Morena (Roma), Italy
Camera Sales: Mauro Sembroni, msembroni@arri.it
Tel: +39 (06)79 89 021, Fax: +39 (06)79 89 02 206

USA

ARRI Inc. (Sales & Service, East Coast)
617 Route 303, Blauvelt, NY 10913-1109, USA
Vice President: Jürgen Schwinzer, jschwinzer@arri.com
Tel: +1 (845)353 1400, Fax: +1 (845)425 1250

ARRI Inc. (Sales & Service, West Coast)
600 North Victory Blvd., Burbank, CA 91502-1639, USA
Vice President: Bill Russell, brussell@arri.com
Tel: +1 (818)841 7070, Fax: +1 (818)848 4028

Canada

ARRI Canada Limited (Sales & Service)
415 Horner Ave. Unit 11 & 12, Toronto, Ontario M8W 4W3, Canada
Accounts Manager, Camera & Digital Systems:
Sébastien Laffoux, seb@arrican.com
Tel: +1 (416)255 3335, Fax: +1 (416)255 3399

Asia

ARRI Asia Limited
Office 3B on 29/F, The Centrium, 60 Wyndham Street, Central, Hong Kong
General Manager: Paul Ivan, pivan@arri.com
Tel: +852 9018 2066, Fax: +852 3755 6371

Australia

ARRI Australia PTY Limited
Unit 6C, 5 Talavera Road, Macquarie Park NSW 2113, Sydney, Australia
General Manager: Stefan Sedlmeier, ssedlmeier@arri.com.au
Tel: +61 (2)9855 4308, Fax: +61 (2)9855 4301

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Arnold & Richter Cine Technik GmbH & Co. Betriebs KG · Türkenstrasse 89 · D-80799 Munich · phone +49 (0)89 3809 0 · fax +49 (0)89 3809 1245 · www.arri.com